15 December 1970

MEMORANDUM FOR: Deputy Chief, OCS

25X1A SUBJECT : [redacted] Implementation Effort

1. This memorandum is a comprehensive review of the 25X1A [redacted] Project to date. It will attempt to show why we are involved in 'front-ending'; the problems we have faced and are facing; the considerations involved in making certain critical decisions; our position now; and finally what direction the 25X1A [redacted] project staff feels we should be taking.

2. The Business of 'Front-Ending':

Two very basic reasons for a front-end computer are

1) to provide switching and
2) to relieve the host processor of the burden of handling communications I/O.

This latter reason manifests itself in several ways:

1) Communications I/O causes an increased load on the central processor due to the number of interrupts generated.

2) The software necessary to handle varying types of terminals is overly-complex. Furthermore, some types of terminals might be prohibited because of hardware restrictions and a lack of software to support them.

3) Communications I/O causes a proliferation of transmission control units which are both costly and at any one point in time dedicated to a particular computer.

These problem areas are present in our computer center to varying degrees.

We now have attached to the 360/67 one 2703, two 2701's, and three 2848's to support the communications requirement to that machine. We expect it to increase. We are required to support various types of devices (2260's, 2741's, teletypes, 1050's) in CP. We cannot implement other terminals unless they are compatible with the aforementioned types without modifying CP. We have two 2701's attached to 360/65-2 for RJE requirements. We have a 100K RJE program in the 65-2 just to support RJE. We are supporting a remote requirement through a 9300 in Office of Communications. We have a large, though really undefined (estimates of 200 terminals have been given), terminal requirement for information retrieval purposes.

There is a possible requirement to support offices remote from the center with OCS computers (IPRD, 9300 [redacted] 25X1A This means more communications lines into our center.

These are the needs (some firm, other projected) that we can see today. More importantly, though, we feel that applications involving communications facilities will increase drastically rather than decrease. We feel that we will have real problems in the next five years coping with these applications unless we start preparing now.

3. What Happened:

It was decided in OCS approximately 1 1/2 years ago to take a positive step towards meeting our future requirements by acquiring a front-end computer. After an initial selection process, a [redacted] computer was brought in for test and evaluation in April 1970. Somewhat before that time, [redacted] 25X1 [redacted] was appointed project leader for the [redacted] project. 25X1A [redacted] was also appointed to the team. Their responsibilities were to represent OCS on a design and implementation team composed of OCS and [redacted] personnel. This team was to: 25X1A

25X1A
25X1A
25X1A

1. Design and implement a communications interface to OS on the 360/65-2 for the purpose of bringing an RJE job stream into OS.

2. Design and implement a communications interface to CP on the 360/67 to handle time-sharing terminals.

A part of the system (hardware and software) that [redacted] provides to its customers is a program called [redacted] which is designed to run in OS as a type IV SVC. This is an access method which provides programs running in OS macros to communicate with the [redacted] processor. Through either a misunderstanding on the part of OCS in the initial selection or a misrepresentation by [redacted] (it has never been clear which was the case) it was the impression of OCS that [redacted] would work for CP. Very early in the design effort it developed that [redacted] would not work for CP and that indeed the interfacing of [redacted] and CP would be a tremendous problem. The design and implementation effort, therefore, became two distinct problems, that of interfacing to OS and that of interfacing to CP.

25X1A
25X1A
25X1A
25X1A
25X1A
25X1A
25X1A
25X1A

4. Interfacing to OS:

It was decided to utilize [redacted] SVC in OS to bring in an RJE job stream. After considering the problem of how to use the SVC, it was decided to implement the interface on an OS reader and writer basis for the following reasons:

25X1A

1. The OS RJE program required 100K bytes of resident core which we felt was unnecessary.

2. The reader/writer interface provides more flexibility for decision on what type of devices could be used as RJE terminals.

3. The reader and writer interface would require less core than OS RJE since they are smaller and are transient.

4. It was felt the reader and writer interface would be less version dependent.

Accordingly, work was started on this type of interface. Detailed RJE specifications were drawn up jointly by [redacted] and OCS personnel with final specifications reviewed, agreed upon, and completed by mid-September 1970. A proposed

25X1A

schedule for software coding, debugging and testing was drawn up and submitted [redacted] Slippage occurred for the following reasons: 25X1A

1. Problems were encountered by [redacted] in generating a Network Control Program (NCP) to meet the RJE specifications. 25X1A

2. There were eight major hardware problems identified.

3. There were unanticipated problems in the complexity of the [redacted] interface in the OS writer. 25X1A

4. The timing problems using [redacted] under CP made it necessary to do all our testing on block time with a dedicated machine. This greatly cut down the available number of test opportunities. 25X1A

5. The FMSAC 2780 terminal was available only on a sporadic basis.

6. There were bugs in [redacted] code. For example, the BSC handler was never properly tested by [redacted] before delivery. 25X1A 25X1A

7. There was a lack of knowledge about the proper 2780 conventions. (This problem complicated pin-pointing bugs in the BSC handler.)

8. [redacted] is very unstable. (An IPL of OS is necessary after running each test program to insure stable conditions). 25X1A

At present (11 Dec 70), the interface is still not complete because of some minor problems in the [redacted] system. 25X1A

The test period indicates that the present [redacted] NCP interface is too unstable for the OCS environment. Solutions include re-writing the [redacted] NCP interface, a new interface or a combination of both. 25X1A 25X1A

5. Interfacing to CP:

When it was learned (early June) that [redacted] could provide no ready software to interface to CP, we began exploring alternatives to solve the problem. Some of the ground rules we established were that it should not cost CP any increase in communications overhead and that modifications to CP should be kept to a minimum. We did not want to make CP any more version dependent than it already was. The two alternatives that emerged from our study were these:

1) [redacted] would build a new Computer Interface Adapter (CIA) which would allow the [redacted] computer to be able to respond to 256 unique addresses on the OS multiplexor channel. This would enable software in the [redacted] computer to emulate any 270X transmission control unit with no impact on host computer software, i.e., existing channel programs within CP (or OS) would not need to be modified. We placed a 95% chance of success on this method. It would, however, cost OCS an additional $50,000 to $100,000.

2) Software in the host computer system would have to be modified to communicate with the [redacted] computer over the existing CIA. This was in fact the method of attack we were already employing in the interface to OS. However, there we had the advantage in that [redacted] was already written. In CP we estimated the software modifications would take 6 to 9 man-months. In addition, another 3 to 4 man-months would be necessary on the [redacted] side.

We recommended alternative 1 above. It would result in a common interface to any IBM machine which has a communications requirement and can support a 270X, and it would have the least impact on existing software. We further recommended a change in the contract for both money and time allocations to reflect this recommendation.

While these activities were being carried on (OS interface testing and evaluating CP alternatives) many discussions were held with OCS management to review the decision to acquire

25X1A [redacted] initially. Some people in OCS were disappointed in performance and the company's financial position. The objections were very well stated in a memorandum to Acting Director of Computer Services, subject: [redacted] dated 25X1A
8 October 1970, written by [redacted] then Chief of Operations 25X1A
Division. The arguments will not be summarized here. After 25X1A
much discussion, a recommendation was made by [redacted]
to re-negotiate the contract and continue developmental work 25X1A
25X1A [redacted] The contract was re-negotiated by [redacted]
and it called for the implementation of our previous recommendation. Some hardware initially contracted for was turned back
25X1A to [redacted] in order to pay for the construction of a new-CIA. As a result the project is still under its initial funding of $340,000.

6. Projected Plans:

The projected plan is summarized in an attachment to this memorandum. Although our new design goals under the revised contract are geared to present requirements of interfacing
25X1A [redacted] to the 360/65's using OS and the 360/67 using CP, the expected advent of future computer technology with parallel processing and an increased sensitivity to interrupts lends added weight to the concept of data concentration. In our proposed tasks we have, therefore, tried to be as flexible as possible in providing for both line and data concentration as well as 270X transmission control unit emulation in the front-end processor. In the proposed systems design, both the capabilities of 270X
25X1A emulation and a [redacted] like interface (providing concentration capability) will be given equal weight. We will implement both in our design if it is at all possible.

25X1A In general, the [redacted] development task as proposed has three major breakdowns (see attachment):

1) Preliminary design - 15 Dec 70 through 30 Jan 71
2) Final detail design - 1 Feb 71 through 30 Apr 71
3) Writing, testing - 1 May 71 through 29 Feb 72

In the preliminary design area, we are attempting to define as many general system requirements as possible. One of the most important questions will be whether it is feasible and practical to do both 270X emulation and a [redacted] like interface 25X1A

simultaneously. Another possible requirement will be message switching. We consider the ability to communicate among the various computers in our center to be an immediate and important requirement. We will consider the feasibility of doing rolling and scrolling in the front-end processor. The 2260 code (assuming we still have 2260's) could be removed from CP. If we have some other CRT devices, the fact that the front-end could roll and scroll for them might mean that we could buy less sophisticated CRTs. Security requirements as well as recovery and/or backup will also be explored.

In the final design phase, we will translate the general requirements arrived at into detailed systems design. Modules to be changed will be identified, requirements in detail will be specified, flow charts drawn and a time schedule for the third phase will be developed.

At various points in phase 1 and phase 2 we will formally review our design with as many knowledgeable people from [redacted] as possible. Arrangements have already been made for [redacted] to provide consulting services. Furthermore, time has been left for formal education on [redacted] software in phase I.

25X1A
25X1A
25X1A

The third phase will be the actual writing and testing of software. We also hope to validate at this time many of the design goals which came out of phases 1 and 2. We do not believe that we will be exactly right in either the philosophy of the system or its details. What we do hope to accomplish is to contribute heavily to OCS's experience and body of knowledge in front-ending as well as providing some operational capability.

Some of the more detailed changes which we can foresee at this time follow. Generally they fall in three areas:

1) Computer interface-adapter software to provide 270X emulation as well as a [redacted] type interface.

25X1A

25X1A

2) [redacted] systems tuning to enhance throughput.

3) Line terminal handlers.

Computer Interface Adapter (CIA) Handler

This handler, which is a part of the [redacted] supervisor, will either be completely rewritten or a module will be added to it to simulate those functions which are now handled by 270X control units. Some of these functions are: 25X1A

* Cyclic Redundancy Check, Vertical Redundancy Check and Longitudinal Redundancy Check

* Status Responses

  Initial Select
  Commands

* Line Addressing Capability

* CCW Analysis

  Commands

In addition, the handler will be modified to distinguish the 270X requests from the [redacted] like requests. [redacted] like requests being 25X1A 25X1A
those which allow the host computer to concentrate data and block messages into one transmission across the channel operating in subselector rather than multiplexor mode. Testing of
25X1A current [redacted] access method in the 360 indicates that present
25X1A [redacted] provided 360 SVC and [redacted] NCP are too unstable 25X1A
for operational use. Proposed modifications would include modifications to the 360 SVC to make it look more like a standard OS access method, and to simplify channel checking procedures back and forth across the channel, reducing interrupt overhead and removing stringent packet restrictions and data restrictions.
25X1A A [redacted] like access method added to OS would present a fairly comprehensive programming effort because interrupts from more than one line presented as data from [redacted] would have 25X1A
to be presented separately to OS so that they could be properly posted and handled.

A number of modules in the Native Processor Support Routine (NPS) as part of NCP would have to be modified or rewritten to properly interface with the new channel requirements.
25X1A For the [redacted] like interface, it is conceivable that the Background

Timing Routine (BGD) and Queue Update Routine (QUPD) would have to be modified to provide the ability to generate interrupts in order to transmit messages in large bursts to the host computers on either a time or size basis. For conversational type terminals with core queued messages, the Selection Routine which would be modified to scan core for full buffers to be transmitted to the host computer, would also incorporate some facility for interfacing to the CIA handler for purposes of transmitting blocks of messages when N number of buffers are full for any given computer. Core Queue Management modules would also be modified.

Prior to final systems specification, it will be necessary to determine the level at which the line handlers must operate and interface to NCP. This requirement is generated because of the need in conversational systems to not generate a new I/O command until the current I/O is actually complete at the terminal. In general, a host computer initiated I/O is complete once it is successfully transmitted across the channel to [redacted] but in terms of the problem program, it may not be complete until it has been transmitted to the terminal, where in a store and forward application, the I/O is obviously complete as soon as it is successfully received by [redacted]

25X1A

25X1A

Systems Enhancements to Improve Throughput

A throughput analysis of the current configuration and system has shown that a number of modifications must be made to the system in order to provide the kind of throughput necessary to support our projected number of at least 200 terminals. This analysis considered conversational messages but did not consider RJE messages. RJE messages, because of their size, require an undetermined number of disk accesses. NCP currently handles data internally on a byte basis. We propose modifying NCP to process I/O on a block or word basis. Current NCP design provides for either core-queued or disk queued messages, but not both at the same time. We recognize the need for both types of queuing, i. e., to core queue conversational type terminals, which have predictable maximum messages sizes, and to disk queue RJE type terminal messages, with varying message sizes. Core queuing is a necessity if we are to achieve the projected throughput. The following is an example of the types of throughputs currently attained and attainable in the system with modifications:

* Standard NCP with 6108 (slow disk) queuing on I/O allows 18 msgs/sec.

* Standard NCP with core queuing on input and 6108 disk queuing on output allows 28 msgs/sec.

* NCP with block or word processing, core queuing on input, 6108 disk queuing on output allows 32 msgs/sec.

* NCP with block or word processing and core queuing on I/O allows 40 msgs/sec.

These figures approach maximum throughput capability of a general purpose communications software package with the scope of NCP. It is probably possible to increase throughput capability by a special purpose package tailored to our needs. A portion of our development on this aspect will be the analysis of throughput capabilities of proposed modifications to system. Another study will consider the maximum achievable capabilities through complete rewrite, tailor-making a package to achieve maximum capability of hardware.

Modules which have to be modified or rewritten are:

1) The Mass Storage Queue modules to allow both core and disk queuing,

2) The Core Queue Buffer Management Routine,

3) The queuing modules which are entered upon scheduling transmission to allow NPS to provide messages from either core or disk,

4) Selection Routines to allow scan to select messages for transmission from core and from disk queues,

5) The Queue Update routine, which appends or deletes sectors as messages are queued and dequeued,

6) Line buffer handling modules must be modified to provide block or word processing.

Another systems enhancement would be the ability to select messages on a priority level for a limited number of lines. Currently, the priority selection scheme requires priority selection for all lines if it is selected at all. In the case of user input from terminals, it might be nice to allow the user to input more than one line, such as when he is creating a new file, wherein his message would have to be disk queued rather than core queued while in input mode. Modifications would have to be made to a number of blocks and routines having to do with queuing so that the status of a terminal can be changed from conversational to nonconversational (disk queued). Current systems design only permits dyntabs, which describe the lines and line groups, to be modified at IPL time. We recommend that this be changed to dynamic modification through the operator console. This would probably entail the addition of a new operator function to the Command Module which is the module which accepts commands from the console and interfaces to the rest of the system.

Line Terminal Handlers

During the design period, we will endeavor to determine the types of line handlers which must be included in the system and make provision for providing them.

It must be stressed that these time estimates and dates are only estimates and subject to change as conditions develop.

25X1A

ATTACHMENT

1. 15 Dec 70 - 30 Jan 71 Preliminary Design

   A. Required 2703 capability
   B. Preliminary consulting [redacted] on the [redacted] Time Sharing System and [redacted] on NCP (Dec 14-18)
   C. Formal Education (Jan 4-9) [redacted]
   D. Block Processing
   E. Core Queuing
   F. Feasibility of a [redacted] like Interface in Conjunction with 2703 Emulation
   G. Preliminary System Requirements for:
      Store and Forward
      Message Switching
      Real-Time Services
      Roll and Scroll
      Security Requirements
      Recovery or Back-up Requirements

2. 1 Feb - 30 Apr 71 Final Detail Design

   A. MA/CIA Handler and Interfaces
   B. Modifications to Native Processor Support (NPS)
   C. [redacted] CIA -- MA/CIA Relationship
   D. Block Processing
   E. Core Queuing
   F. Level of Operation and Interfaces of Line Handlers to the Remainder of NCP
   G. Other: Communication Interfaces
      9300 Interfaces
      ASP Interfaces
   H. Final Detail Specifications for Each Module (New or Modified)
   I. Time Schedule for Next Phase

3. 1 May 71 - 29 Feb 72 Code, debug, comprehensive system testing, experimentation and validation of design philosophies and requirements.

SENDER WILL CHECK CLASSIFICATION TOP AND BOTTOM		
UNCLASSIFIED	CONFIDENTIAL	SECRET

OFFICIAL ROUTING SLIP

TO	NAME AND ADDRESS	DATE	INITIALS
1	DDS/IPC 7 D 02 HQ		
2			
3			
4			
5			
6			

	ACTION		DIRECT REPLY		PREPARE REPLY
	APPROVAL		DISPATCH		RECOMMENDATION
	COMMENT		FILE		RETURN
	CONCURRENCE		INFORMATION		SIGNATURE

Remarks:

25X1A

The attached provides a status report on the [redacted] communications processor. Pardon the jargon, but the subject is rather technical. Summary: We have much work to do to get [redacted] into productive use.

25X1A

FOLD HERE TO RETURN TO SENDER		
FROM: NAME, ADDRESS AND PHONE NO.		DATE
D/OCS	[redacted]	12/30/70

25X1

FORM NO. 237 1-67 Use previous editions (40)